

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date
25 March 2004 (25.03.2004)

PCT

(10) International Publication Number
WO 2004/025865 A1

(51) International Patent Classification⁷:

H04B 1/74

(21) International Application Number:

PCT/NO2002/000318

(22) International Filing Date:

10 September 2002 (10.09.2002)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant (for all designated States except US): TELEFONAKTIEBOLAGET LM ERICSSON [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): SCHIRDEWAHN, Jochen, Christof [DE/NO]; Velliveien 11B, N-1358 Jar (NO).

(74) Agent: OSLO PATENTKONTOR AS; P.O. Box 7007 M, N-0306 Oslo (NO).

(81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

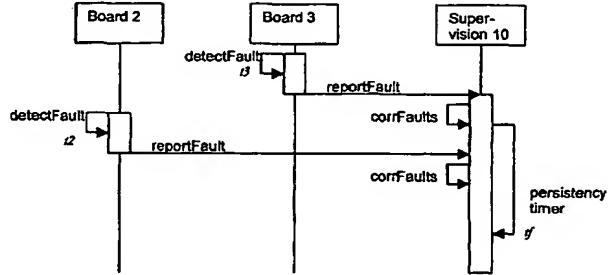
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG,

[Continued on next page]

(54) Title: SYSTEMS FOR PROTECTION LINK SUPERVISION



Note: t2/t3 and tf are event IDs to be referred by timing analysis.

(57) **Abstract:** The invention relates to a system for protection link fault supervision between two nodes (1, 11) in a transmission network. The nodes (1, 11) are connected by first (6) and second (8) transmission lines carrying identical data traffic between the nodes (1, 11). Each node (1, 11) includes a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8). Each node also includes a node core (4) with a link supervision block (10). The line termination boards (2, 3) are adapted to report faults to the link supervision block (10), whereupon the node core (4) will switch traffic between the line termination boards (2, 3). In a preferred embodiment of the invention both line termination boards (2, 3) are adapted to report fault state changes spontaneously when they are detected to the link supervision block (10), the link supervision block (10) is adapted to store received fault causes and correlate the latest received fault causes from each line termination board (2, 3) with the latest received fault cause from the other line termination board (2, 3), the system further including a persistency timer adapted to be started by the link supervision block (10) in order to supervise the persistency of a correlation result, if the correlation result has not disappeared during a persistency timer period, the link supervision block (10) is adapted to request the node core (4) to switch traffic between the line termination boards (2, 3).



MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

10/526720

Rec'd 10/526720

Systems for Protection Link Supervision

C47AR 2005

Technical Field

The present invention relates to a system of performing protection link fault supervision in a Synchronous Digital Hierarchical (SDH) based network. The principles of the SDH protocol are described in International Telecommunication Union recommendation ITU G.707.

Technical Background

To connect Radio Network Controller nodes to form a Radio Access Network, there is a need to protect the physical lines connecting these nodes against failure. A common architecture to achieve line protection in an SDH based network uses two physical lines to connect two nodes of the network. The node that is sending the data traffic, sends the data on two lines to the receiving node. If one of the lines breaks, the receiving node can extract the traffic from the other line.

The RNC node includes two line termination boards, of which one is active and the other is in standby mode. A link supervision block supervises the function of the lines and termination boards, and performs a switchover from the active to the standby board should a fault occur on one of the connections.

In the AXE system manufactured by Telefonaktiebolaget LM Ericsson such a supervision system is implemented. Faults detected on the active board are sent towards the supervision block spontaneously when they are detected. The supervision block then reads out state information from the standby board. The results are correlated to achieve information about a fault cause (failure in the active board or the connected line, failure in the standby board

or the connected line, failure in the internal link between the boards, no failure).

Such a system is prone to some problems:

- 5 We can imagine that an identical fault is detected on both boards. Due to varying detection and signal transmission times, it is undetermined which fault (i.e. from which board) that will be reported first. Then the correlation result might not reflect the true physical situation, and the supervision block may misunderstand the situation.
- 10 Varying detection times is caused by the standby board not reporting faults immediately, but instead checks the situation at fixed time intervals.

Even a single short disturbance can lead to a failure being reported without being justified.

- 15 In addition, the active and standby boards have two rather different functions. In case of failure, the functions must be swapped, without loosing information on the faults that has occurred. This might be complicated to implement in a computer program.

20 **Summary of the invention**

It is an object of the present invention to provide a supervision system for protecting transmission paths in radio access networks, which is more reliable in deciding the true cause of a fault.

- 25 Another object of the invention is to provide a system that is nearly immune against random disturbances.

Still another object is to provide a system that is less costly to implement than prior art systems.

These and other objects are achieved in a system as defined in the appended patent claims.

Brief description of the drawings

The invention will now be described in detail in reference
5 to the appended drawings, in which

Fig. 1 gives a schematic overview of the circuitry used in current radio access network nodes in order to protect against line faults,

Fig. 2 is a sequence diagram showing the detection of a
10 fault in the system outlined in Fig. 1 (prior art),

Fig. 3 shows a similar diagram and the detection of faults in a system according to the present invention.

Detailed description of the invention

Fig. 1 shows two radio access network nodes, 11 and 1, with
15 redundant lines, 6 and 8, between the nodes for securing a reliable connection between them.

The node 1 has an active Line Termination Board 2 that carries the data traffic, a passive Line Termination Board 3 that can be used as a replacement and a Node Core 4 that
20 switches the data traffic and contains a Link Supervision instance 10.

The incoming data traffic is sent from a source node 11. The data source 5a sends via link 6 towards the active board 2. The same data traffic is sent by the data source
25 5b via link 8 to the passive board 3 and further via the internal link 9 to the active board 2 that selects one of the two external links as an input and sends the data further via internal link 7 towards the core 4.

In normal operation the active board 2 has the role of the working board, it takes the data traffic from link 6. Board 3 has the role of the standby board, it forwards the incoming traffic to the active board.

- 5 When link 6 becomes unusable, the data traffic is taken from internal link 9 (protected operation). The Link Supervision Block 10 controls the switch between these two modes. The roles of the boards are swapped.

10 Essential for the usability of the protected operation mode is the absence of faults that might disturb data traffic on internal link 9. Therefore the supervision block 10 needs information about the transmitter state from board 3 and about the receiver state from board 2. Information from both boards is needed to be able to decide about the cause 15 of a possible fault to determine if a switch is possible or needed.

As explained earlier, faults detected on the working board 2 will be sent towards the supervision block 10 spontaneously when they are detected. The supervision block 20 then reads out the state information from the standby board 3. The results are correlated to achieve information about a fault cause (failure in board 2, failure in board 3, link failure, no failure).

25 In one instance one class of faults is detected on both boards. Due to varying detection and signal transmission times, it is not determined which fault will be reported first $\{t_3 < t_2\}$ or $\{t_3 > t_2\}$. It is possible that the fault on board 3 is detected after the information was read out $\{t_3 - t_{r3} > 0\}$. Then the correlation result at $\{tf\}$ does not 30 reflect the physical situation.

Varying detection times can e.g. be caused by checks that are triggered by expiry of a fixed-period timer. Since

these faults can not be detected between the checks, the detection time may vary from 0 up to a time period.

The correlation result is not checked for persistency in a defined period. This might lead to unjustified failure from 5 the supervision block towards an operator in case of a single short disturbance.

The implementation of this method as a software program is expensive because the two different roles of the board imply different reactions upon fault detection. Only the 10 working one reports spontaneously, the functionality to switch between the two roles must be implemented in a way that secures that knowledge on initial faults of the standby board are preserved.

Fig. 3 shows the timing diagram for a system according to 15 the invention. The hardware is as described in Fig. 1. However, several new functions are implemented in the line boards 2,3 and the supervision block 10.

According to a first embodiment of the invention, the following actions are performed when each of the boards 2,3 20 detect a fault state change:

Both boards report all fault state changes spontaneously when they are detected to the supervision block.

The supervision block stores the received faults causes.

The received fault cause is correlated with the latest 25 received fault cause of the board terminating the other end of the link.

A timer is started to supervise the persistency of the correlation result.

When the result has not disappeared during the persistency timer period, it can be reported.

If the correlation result shows that a traffic-disturbing fault on the link has occurred and that the traffic can be 5 reestablished by some actions is the node, e.g. re-routing, then these actions can be started.

One advantage of this system is that the result of the supervision block is as accurate as possible since all fault changes are reported immediately after detection.

10 This overcomes the timing problems of the known solution.

The persistency check ensures that the correlation result is correct and stable.

The timeout can be selected to fulfill system requirements for a specified detection time.

15 The timeout can be selected to suppress short time disturbances.

The method is inexpensive and can thereby easily be implemented as a computer program because the fault 20 detection mechanism in both boards is independent of the board's role (working/standby) .

In an alternative embodiment of the invention an additional persistency check is implemented before the correlation is done. If this check is done by the reporting board, the amount of signaling towards the supervision block can be 25 reduced in case of faults that change state with a high frequency. With this pre-correlation check, the persistency check after correlation could be left out under certain circumstances.

While the present invention has been described in relation 30 to SDH based networks, the applicability is not restricted

to this particular type of network. All transmission techniques can be used that support error detection. Thus, this system can be used for general link supervision, when information about the sender of data traffic as well as 5 information about the receiver of data traffic is available at different locations and needs to be correlated to gain information about the state of the link.

Patent claims

1. System for protection link fault supervision between two nodes (1, 11) in a transmission network, the nodes (1, 11) being connected by first (6) and second (8) transmission lines carrying identical data traffic between the nodes (1, 11), each node (1, 11) including a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8), and a node core (4) including a link supervision block (10), said line termination boards (2, 3) being adapted to report faults to the link supervision block (10), said node core (4) being adapted to switch traffic between the line termination boards (2, 3) in case of a fault,

characterized in that both line termination boards (2, 3) are adapted to report fault state changes spontaneously when they are detected to the link supervision block (10),
the link supervision block (10) is adapted to store received fault causes and correlate the latest received fault causes from each line termination board (2, 3) with the latest received fault cause from the other line termination board (2, 3),

the system further including a persistency timer adapted to be started by the link supervision block (10) in order to supervise the persistence of a correlation result, if the correlation result has not disappeared during a persistency timer period, the link supervision block (10) is adapted to request the node core (4) to switch traffic between the line termination boards (2, 3).

2. System as claimed in claim 1,
characterized in that each line termination board (2, 3) includes an additional persistency timer,
when a fault is detected in one of the boards (2, 3) the

board is adapted to start its additional persistency timer in order to supervise the persistence of the detected fault,

5 if the fault has not disappeared during a persistency timer period, the line termination board is adapted to report the fault to the link supervision block (10).

3. System as claimed in claim 1 or 2,
characterized in that said transmission
network is a Synchronous Digital Hierarchical based
10 network.

4. System for protection link fault supervision between two nodes (1, 11) in a transmission network, the nodes (1, 11) being connected by first (6) and second (8) transmission lines carrying identical data traffic between
15 the nodes (1, 11), each node (1, 11) including a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8), and a node core (4) including a link
20 supervision block (10), said line termination boards (2, 3) being adapted to report faults to the link supervision block (10), said node core (4) being adapted to switch traffic between the line termination boards (2, 3) in case of a fault,

25 characterized in that each line termination board (2, 3) includes a persistency timer,
when a fault is detected in one of the line termination boards (2, 3) the line termination board is adapted to start its persistency timer in order to supervise the
30 persistence of the detected fault.

if the fault has not disappeared during a persistency timer period, the line termination board is adapted to immediately report the fault to the link supervision block (10),

35 the link supervision block (10) being adapted to store received fault causes and correlate the latest received

fault causes from each board with the latest received fault cause from the other board,
if the link supervision block (10) decides that a fault has occurred, it is adapted to request the node core (4) to
5 switch traffic between the line termination boards (2, 3).

5. System as claimed in claim 4,
characterized in that said transmission network is a Synchronous Digital Hierarchical network.

1 / 2

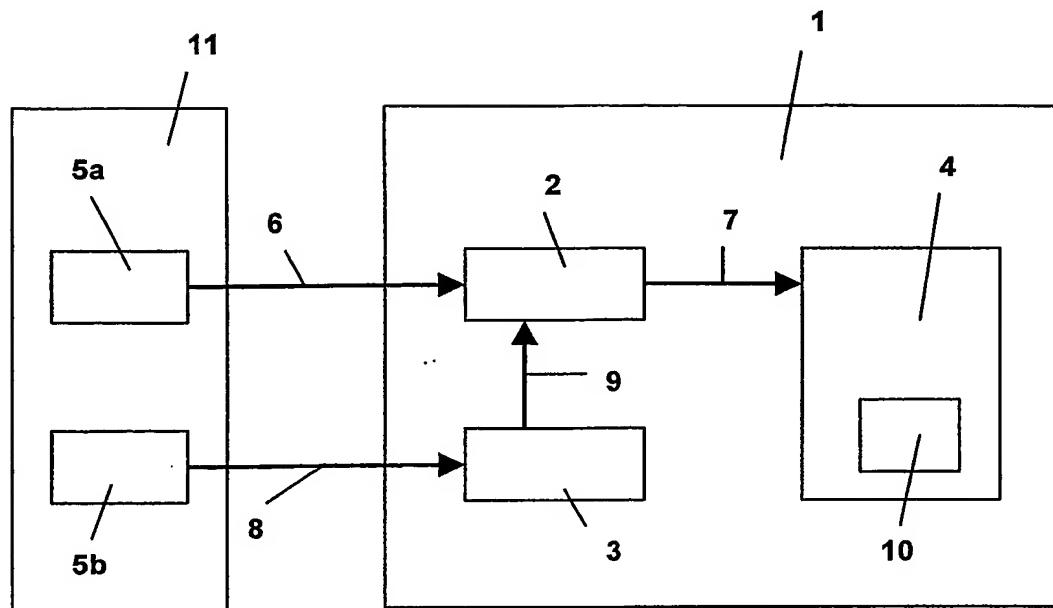
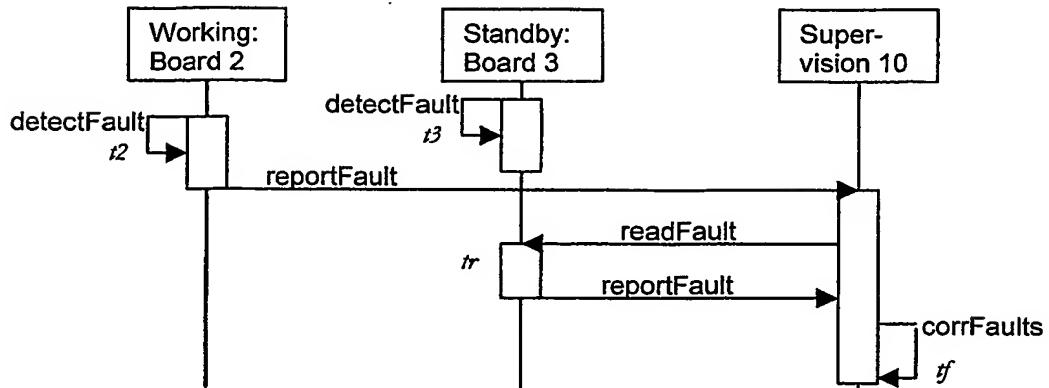


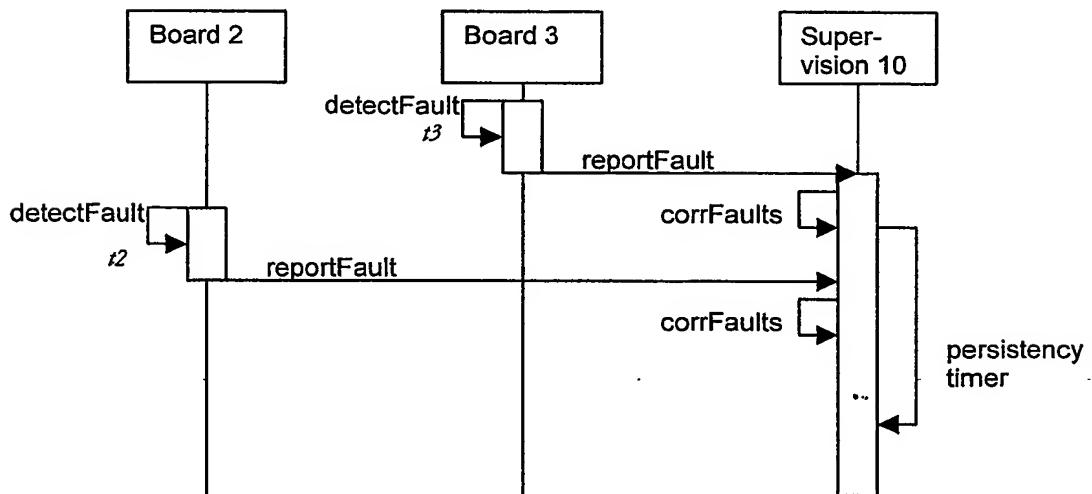
fig. 1

2 / 2



Note: $t2, t3, tr$ and tf are event IDs to be referred by timing analysis.

fig. 2



Note: $t2, t3$ and tf are event IDs to be referred by timing analysis.

fig. 3

INTERNATIONAL SEARCH REPORT

Inte... Application No
NO 02/00318

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04B1/74

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WHITE PAPER: "Automatic Protection Switching on the CBX 500 and GX 550 Multoservice WAN Switches" LUCENT TECHNOLOGIES, INC., August 2001 (2001-08), XP002239095 page 4, line 42 -page 5, line 8 ---	1-5
A	US 6 294 991 B1 (BENGSTON LEE ET AL) 25 September 2001 (2001-09-25) column 2, line 28 - line 63 abstract ---	1-5
A	EP 0 824 292 A (LUCENT TECHNOLOGIES INC) 18 February 1998 (1998-02-18) page 4, line 29 - line 39 page 5, line 13 - line 53 abstract ---	1-5
	-/-	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

23 April 2003

Date of mailing of the international search report

19. 05. 2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

ÅSA HÄLLGREN/JA A

INTERNATIONAL SEARCH REPORTInt'l Application No
NO 02/00318**C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ACHIM AUTENRIETH ET AL: "Evaluation of multi-layer recovery strategies" EUNICE'98 - OPEN EUROPEAN SUMMER SCHOOL, MUNICH, GERMANY, September 1998 (1998-09), XP002239096 paragraph [03.2] paragraph [04.2] - paragraph [04.3] -----	1-5

INTERNATIONAL SEARCH REPORT

Inte

Application No
NU 02/00318

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
US 6294991	B1	25-09-2001	NONE		
EP 0824292	A	18-02-1998	US 5838924 A	17-11-1998	
			CA 2207538 A1	06-02-1998	
			EP 0824292 A2	18-02-1998	
			JP 10084362 A	31-03-1998	